PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Ex Parte John M. Kulp

Appeal No. _____

Serial No.:	10/675,419
Group Art Unit:	6182
Applicant:	John M. Kulp
Title:	**SACRIFICIAL SURFACTANATED PRE-WET FOR DEFECT REDUCTION IN A SEMICONDUCTOR PHOTOLITHOGRAPHY DEVELOPING PROCESS**
Attorney Docket:	CT-001
Confirmation No.:	6182

Cincinnati, Ohio 45202 June 7, 2007

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BRIEF ON APPEAL

This brief is in furtherance of Appellant's Notice of Appeal filed February 9, 2007 appealing the decision of the Examiner dated October 11, 2006, finally rejecting claims 1-35 (all pending claims). A copy of the claims appears in the Claims Appendix to this brief.

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I. Real Party In Interest

The real party in interest in this appeal is Tokyo Electron Limited, a corporation of Japan having a place of business at 3-6 Akasaka 5-chome, Minato-ku, Tokyo, JAPAN.

II. Related Appeals and Interferences

There are no related appeals or interferences known to Appellant, the Appellant's legal representative, or to the assignee which will directly affect or be directly affected by or have a bearing on the decision of the Board in the present appeal.

III. Status of Claims

Claims 1-35 are rejected. Claims 1-35 are currently pending and are subject to this appeal.

IV. Status of Amendments

A proposed Amendment was filed February 9, 2007, but was denied entry because the proposed amendment allegedly raised new issues that would require further consideration and/or search.

V. Summary of Claimed Subject Matter

Claims 1 and 20 are independent claims.

Independent claim 1 is directed to a method of developing the resist film formed on a substrate, as depicted in the flowchart of FIG. 7. Claim 1 recites a method comprising the step of applying a surfactant-containing liquid onto the resist film, as described for example in paragraphs [0007]-[0009], [0018]-[0019], [0052], [0060], [0063], and [0065]. This step is subsequently followed by displacing the surfactant-containing liquid with a developing solution of selected concentration, as described for example in paragraphs [0007]-[0009], [0018]-[0019], [0053], [0057], [0060], [0063], and [0066]. After the developing solution is applied, the developing reaction is allowed to proceed using the developing solution, as described for example in paragraphs [0019] and [0068].

Independent claim 20 includes the elements of claim 1 and further recites that the method comprises the step of depositing a resist film on the substrate, as described for example in

paragraphs [0002], [0021], and [0032]. Claim 20 further recites applying a surfactant-containing liquid onto the resist film, wherein the surfactant-containing liquid is chosen based on one or more characteristics of the resist film, as described for example in paragraphs [0008], [0063], and [0075]. The concentration of a developing solution is selected in accordance with one or more characteristics of the surfactant-containing liquid and the resist film, as described for example in paragraphs [0008], [0017], [0019], [0063], [0064], [0072], [0074], [0075], and [0078]. The next step is supplying the developing solution onto the resist film after applying the surfactant-containing liquid on the substrate, as described for example in paragraphs [0018], [0019], [0020], [0053], [0057], [0060], and [0067]. The resist film is developed by allowing the substrate having the developing solution supplied thereto to stand for a prescribed time sufficient to permit a developing reaction to proceed, as described for example in paragraphs [0062] and [0068], and thereafter the substrate is rinsed, as described for example in paragraphs [0062], [0069], and [0077].

VI. Grounds of Rejection to be Reviewed on Appeal

A. Claims 1, 3, 11, 14, 17 and 19 are rejected under 35 U.S.C. § 102(e) as being anticipated by Takizawa U.S. Patent No. 6,472,127.

B. Claims 2, 4-5, 9-10 and 18 are rejected under § 103(a) as being unpatentable over Takizawa in view of Phan et al. U.S. Patent No. 6,136,514.

C. Claims 6-8 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Takizawa in view of Ogata U.S. Patent No. 5,845,170.

D. Claims 12-13 and 15-16 are rejected under § 103(a) as being unpatentable over Takizawa in view of Hayasaki et al. U.S. Patent Application Publication No. 2004/0029026.

E. Claims 20-21, 23-25, 28, 31 and 34-35 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Takizawa in view of Phan et al.

F. Claim 22 is rejected under § 103(a) as being unpatentable over Takizawa in view of Phan et al., and further in view of Maemori et al. U.S. Patent Application Publication No. 2002/0058202.

G. Claims 26-27 are rejected under § 103(a) as being unpatentable over Takizawa in view of Phan et al., and further in view of Ogata.

H. Claims 29-30 and 32-33 are rejected under § 103(a) as being unpatentable over Takizawa in view of Phan et al., and further in view of Hayasaki et al.

VII. Argument

A. Rejection of Claims 1, 3, 11, 14, 17 and 19 as being anticipated by Takizawa.

It is the Examiner's position that the method of forming a photoresist pattern disclosed in Takizawa includes each element of Applicant's claimed method for developing a resist film. In support of this conclusion, the Examiner states "Takizawa…disclose (sic) a method for developing a resist film formed on a substrate wherein an aqueous solution of a surfactant is applied onto the photoresist film, followed by *displacing* the surfactant film formed by applying the developing solvent of a predetermined concentration on the photoresist film to develop the photoresist film." (Page 3, Paragraph 6 of Final Rejection mailed 10/11/2006, emphasis added.) Contrary to the Examiner's position, Appellant believes that Takizawa discloses modification of the photoresist surface by forming a "surfactant layer" upon which the developing solution is applied, whereas the Applicant's claimed invention invokes "displacing the surfactant-containing liquid," which liquid is thus merely sacrificial by virtue of this displacement.

Takizawa recites the term "surfactant" to denote the defect preventive agent containing a hydrophobic group and a hydrophilic group, i.e. a chemical substance, throughout the Detailed Description of the Preferred Embodiments. In differentiation, Takizawa discloses applying "aqueous solutions of a surfactant" to the photoresist layer, denoting a solution with water as the solvent and the surfactant as the solute. (*See generally* Abstract; Col. 8, lines 6-7, 21-22, 25-26, 37-38, 66.) Takizawa discloses that "an aqueous solution of a surfactant...is…applied to the photoresist film…to form a *surfactant layer 18 of a monomolecular or polymolecular film* on the surface of the photoresist film 12." (Col. 6, lines 39-45, emphasis added.)

Appellant believes that Takizawa describes the application of an aqueous solution of a surfactant, whereby the surface of the photoresist film is modified via the formation of a surfactant layer and not a surfactant solution layer. Takizawa discloses that this surfactant layer is formed by the action of "hydrophobic groups 19 of the surfactant attach to the surface of the photoresist film 12, and the hydrophilic groups 20 also attach to the hydrophilic groups 19…[h]ence, the surface of the photoresist film 12 changes to be hydrophilic." (Col. 6, lines 46-

50.) Takizawa describes the persistence of the surfactant layer into the development stage, "reattachement of a developing solvent component to the surface of the photoresist film 12 is moderated…." (Col. 6, lines 50-54.)

Moreover, Takizawa describes that this surfactant layer is formed by "spin coating with the motor 16 at 2,000 rpm to 4,000 rpm." (Col. 6, lines 42-44.) It is the Appellant's belief that at these coating speeds, it is almost impossible to leave a liquid on the surface of the photoresist layer of the nature claimed in Applicant's invention. Therefore, as Takizawa describes, the surfactant layer, not a surfactant-containing solution, operates to modify the surface of the photoresist layer to be hydrophilic. (Col. 6, lines 46-50.) In other words, the solution is applied, the surfactant bonds to the surface to form a surfactant layer while the solvent leaves the surface due to the high rotational speed, and then a developing solution is applied onto the surfactant layer with no displacement of the surfactant.

In contrast, Appellant's claimed invention provides a fundamentally different method for minimizing developing defects. A surfactant reduces the surface tension of the medium in which it is dissolved, which enables more uniform spreading of this sacrificial surfactant-containing liquid. (Paragraph 5, lines 8-9.) The lower surface tension substantially, if not completely, avoids the defect mechanism of the high developing liquid contact angle on the resist surface (Paragraph 9, lines 18-20). Appellant's invention claims the application of a surfactant-containing liquid to the surface of the photoresist layer. The surfactant does not attach to the surface, but rather, remains in solution. Appellant further requires the resultant layer of surfactant-containing liquid to be displaced with a developing solution of selected concentration. In other words, both the surfactant and the solvent are displaced by the developing liquid, such that each element of the surfactant-containing solution leaves the surface in favor of the developing solution. The presence of the surfactant-containing liquid on the surface is completely temporary, serving the purpose of lowering the contact angle of the developing liquid as it is applied so as to avoid defects. While both the claimed invention and the prior art seeks the goal of defect prevention, the solutions apply different mechanisms to achieve that goal. The claim limitation of "displacing the surfactant-containing liquid" is not taught by Takizawa.

Claims 3, 11, 14, 17 and 19 are all dependant claims from Claim 1. All statements made above, with respect to Takizawa and Claim 1, applies equally to Claim 3, 11, 14, 17, and 19.

Therefore, for at least the aforementioned reasons, the Takizawa patent does not teach the claimed invention, and the rejection of claims 1, 3, 11, 14, 17, and 19 should be reversed.

B. Rejection of Claims 2, 4-5, 9-10 and 18 over Takizawa in view of Phan et al.

The arguments made above in Section A with respect to Takizawa for independent claim 1 apply equally to this ground of rejection. The Examiner cites Phan et al. for the purpose of describing a method of determining the concentration for the surfactant-containing liquid based on the characteristics of the resist film and the water solubility of the resist film, and a method of determining the concentration of the developing solution based on resist film characteristics and the resist activating solution properties.

In support of the Examiner's rejection, the Examiner concluded that it would be obvious to a skilled artisan to modify Takizawa reference with the descriptions supplied in Phan et al. because Phan discloses that the "resist activating solution promotes the reduction of the surface tension of the developer, promotes hydrophilicity of the resist film and thereby reduces contact angle, prevents the formation of micro bubbles during development." (Page 4, lines 21-22; page 5, lines 1-4, Final Rejection mailed 10/11/2006.) The Appellant respectfully traverses the obviousness rejection and asserts the belief that Takizawa teaches away from the claimed invention and from combining Takizawa with Phan et al. Moreover, the combination fails to teach each and every element of the claims. Therefore, Appellants believe the claimed invention is not obvious and request that this Court reverse the rejections.

"To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations." MPEP § 2143. It is duly noted that "[t]he obviousness analysis cannot be confined by a formalistic conception of the words teaching, suggestion, and motivation." *KSR Int'l. Co. v. Teleflex, Inc.* 550 U.S. __, slip op. at 15 (2007). However, a prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. MPEP 2141.02.VI (citing *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984).) In addition, the

obviousness analysis requires that each and every element of the claimed invention be taught or suggested. It is improper to combine references where the references teach away from their combination, *In re Grasselli*, 713 F.2d 731, 743, 218 USPQ 769, 779 (Fed. Cir. 1983), and each element must be taught or suggested for a claimed invention to be deemed obvious.

Takizawa addresses a method of forming a photoresist pattern and discloses an invention to decrease development defects by treating the photoresist film with an aqueous solution of a surfactant to form a surfactant layer that remains on the surface to modify the surface properties. (Abstract.) Takizawa teaches away from a method in which the surfactant is removed, i.e., displaced, from the surface by the subsequently applied developing solution. Phan et al. do not teach or suggest the claimed displacement. Thus, the combination of references does not teach or suggest each element of the claimed invention, and moreover, the missing claim element is taught against by the primary reference, Takizawa. In addition, Takizawa is silent as to the concentration of the surfactant solution and does not disclose or suggest a method of determining the concentration of the surfactant solution. Takizawa fails to suggest that the concentration of the surfactant is a problem in need of a solution and provides no suggestion or motivation to combine the teachings of Phan et al. Moreover, the Appellant believes that Takizawa's failure to address surfactant concentration suggests that the nature of the surfactant (anionic, cationic, ampholytic, or nonionic) and its variability within each class, including manipulations of the alkyl group substituents, are controlling defects. (Col. 9, lines 41-44.) Therefore, Appellant believes that Takizawa teaches away from combining the disclosure of Phan et al. Thus, absent a suggestion or motivation to combine with other references, the Appellant's invention is not obvious and the rejection of claims 2, 4-5, 9-10, and 18 are requested to be reversed.

Furthermore, Phan et al. discloses a method to conserve resist developer solution, while improving the resolution of the development of a photoresist. (Col. 1, lines 6-9.) Phan et al. discloses several ranges of surfactant concentrations (based on weight percentage), but, as interpreted by the Appellant, fails to teach that the range of concentrations is based on one or more characteristics of the resist film. As such, the combination of Takizawa and Phan et al. fail to teach all the elements of claim 2. Therefore the rejection of claim 2 should be reversed.

C. Rejection of Claims 6-8 over Takizawa in view of Ogata.

Appellant's claims 6-8 are dependent upon claim 1. The arguments made above in Sections A and B with respect to Takizawa for independent claim 1 apply equally to this ground of rejection. Ogata fails to teach Appellant's requirement that the resultant layer of surfactant-containing liquid is displaced with a developing solution of selected concentration, as stated in claim 1. Therefore, either alone or in combination, Takizawa and Ogata fail to teach all the elements of Appellant's claims 6-8. Thus, the Appellant urges the board to reverse this rejection.

D. Rejection of Claims 12-13 and 15-16 over Takizawa in view of Hayasaki et al.

Appellant's claims 12-13 and 15-16 are dependent claims from claim 1. The arguments made above in Sections A and B with respect to Takizawa for independent claim 1 apply equally to this ground of rejection. Hayasaki et al. fails to teach Appellant's requirement that the resultant layer of surfactant-containing liquid is displaced with a developing solution of selected concentration, as stated in claim 1. Therefore, either alone or in combination, Takizawa and Hayasaki et al. fail to teach all the elements of Appellant's claims 12-13 and 15-16. Thus, the Appellant's urge the board to reverse this rejection.

E. Rejection of Claims 20-21, 23-25, 28, 31 and 34-35 over Takizawa in view of Phan et al.

The arguments made above in Section A, with respect to Takizawa, and in Section B, with respect to Takizawa and Phan et al., apply equally to this ground of rejection. Both Takizawa and Phan et al. fail to teach Appellant's requirement that the resultant layer of surfactant-containing liquid is displaced with a developing solution of selected concentration, as stated in claim 20, and Takizawa teaches against such displacement. Therefore, either alone or in combination, Takizawa and Phan et al. fail to teach all the elements of Appellant's claim 20. Claims 21, 23-25, 28, 31, and 34-35 are dependant claims, depending from claim 20. Therefore, the rejections of these claims should be reversed.

F. Rejection of Claim 22 over Takizawa in view of Phan et al., and further in view of Maemori et al.

The arguments made above in Section A, with respect to Takizawa, and in Section B, with respect to Takizawa and Phan et al., apply equally to this ground of rejection. In addition, neither Takizawa nor Phan et al. teach of the resist layer thickness being a variable to consider

for determining the concentration of the surfactant solution. In direct contradiction, Phan et al. specifically teaches that the "thickness of the resist is not critical to the invention." (Col 3, lines 11-12.) Phan et al. teaches away from the teachings in Maemori et al. Therefore, in light of Takizawa failure to consider the concentration of the surfactant and Phan et al.'s teaching that the "thickness of the resist is not critical to the invention," whether alone or in combination, neither would provide motivation to combine the teachings of Maemori et al. As such, the Applicant urges the Board to reverse this rejection.

G. Rejection of Claims 26-27 over Takizawa in view of Phan et al., and further in view of Ogata

Claims 26-27 are dependent claims and depend from claim 20. The arguments made above in Section A (with respect to Takizawa), in Section B (with respect to Takizawa and Phan et al.), and Section E (with respect to Takizawa and Phan et al.), apply equally to this ground of rejection. Takizawa, Phan et al., and Ogata fail to provide teachings or motivation to combine the references. Moreover, Takizawa, Phan et al., and Ogata fail to teach Appellant's requirement that the resultant layer of surfactant-containing liquid is displaced with a developing solution of selected concentration, as stated in claim 20, and Takizawa teaches against such displacement. Therefore, either alone or in combination, Takizawa in view of Phan et al., further in view of Ogata fail to teach all the elements of Appellant's claims 26-27. Therefore, the rejections of these claims should be reversed.

H. Rejection of Claims 29-30 and 32-33 over Takizawa in view of Phan et al., and further in view of Hayasaki et al.

Claims 29-30 and 32-33 are dependent claims and depend from claim 20. The arguments made above in Section A (with respect to Takizawa), in Section B (with respect to Takizawa and Phan et al.), and Section E (with respect to Takizawa and Phan et al.), apply equally to this ground of rejection. Takizawa, Phan et al., and Hayasaki et al. fail to provide teachings or motivation to combine the references. Moreover, Takizawa, Phan et al., and Hayasaki fail to teach of Appellant's requirement that the resultant layer of surfactant-containing liquid is displaced with a developing solution of selected concentration, as stated in claim 20, and Takizawa teaches against such displacement. Therefore, either alone or in combination, Takizawa in view of Phan et al., further in view of Hayasaki et al. fail to teach all the elements of

Appellant's claims 29-30 and 32-33. Therefore, the rejections of these claims should be reversed.

Respectfully Submitted,

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Claims Appendix

1. A method for developing a resist film formed on a substrate, the method comprising the steps of:

applying a surfactant-containing liquid onto the resist film;

displacing the surfactant-containing liquid film with a developing solution of selected concentration; and

developing the resist film using the developing solution.

2. The method as claimed in claim 1, the method further comprising:

determining a concentration for the surfactant-containing liquid based on one or more characteristics of the resist film.

3. The method as claimed in claim 1, wherein the surfactant-containing liquid comprises at least one of an ionic surfactant, a nonionic surfactant, an anionic surfactant, and a cationic surfactant.

4. The method as claimed in claim 1, the method further comprising:

determining a concentration for the surfactant-containing liquid based on the resist film and selecting the concentration for the developing solution based on one or more characteristics of the surfactant-containing liquid and the resist film.

5. The method as claimed in claim 1, the method further comprising:

determining a contact angle for the developing solution on the resist film; and

determining a concentration for the surfactant-containing liquid effective to achieve a decrease in the contact angle.

6. The method as claimed in claim 1, the method further comprising:

prior to applying the surfactant-containing liquid, transferring the substrate having the resist film thereon into a developing unit; and

positioning the substrate on a spin chuck,

wherein the applying and displacing are performed while rotating the spin chuck.

7. The method as claimed in claim 6, wherein the developing includes allowing the developing solution to stand on the resist film for a prescribed time sufficient to permit a developing reaction to proceed, and wherein the method further comprises:

after the developing, rinsing the substrate while rotating the spin chuck.

8. The method as claimed in claim 7, the method further comprising:

after the rinsing, drying the substrate while rotating the spin chuck; and

transferring the substrate out of the developing unit.

9. The method as claimed in claim 1, wherein an exposed portion and an unexposed portion of the resist film have a difference in solubility, the method further comprising:

determining a concentration for the surfactant-containing liquid based on at least one of the solubility of the exposed portion of the resist film and solubility of the unexposed portion of the resist film.

10. The method as claimed in claim 1, the method further comprising:

determining a concentration for the surfactant-containing liquid based on the water solubility of the resist film.

11. The method as claimed in claim 1, further comprising rotating the substrate during the step of applying, and wherein the step of applying a surfactant-containing liquid onto the resist film is carried out by using a nozzle capable of depositing the surfactant-containing liquid in a substantially circular shape, the nozzle being positioned over the center of the substrate while depositing the surfactant-containing liquid onto the rotating substrate.

12. The method as claimed in claim 1, wherein the step of applying a surfactant-containing liquid onto the resist film is carried out by using a nozzle capable of depositing the

surfactant-containing liquid in substantially a band shape, the nozzle being scanned over the substrate while depositing the surfactant-containing liquid.

13. The method as claimed in claim 1, wherein the step of applying a surfactant-containing liquid onto the resist film is carried out by using a plurality of nozzles each capable of depositing the surfactant-containing liquid in substantially a band shape, the plurality of nozzles being scanned over the substrate while depositing the surfactant-containing liquid.

14. The method as claimed in claim 1, further comprising rotating the substrate during the step of displacing, and wherein the step of displacing the surfactant-containing liquid with a developing solution is carried out by using a nozzle capable of depositing the developing solution in a substantially circular shape, the nozzle being positioned over the center of the substrate while depositing the developing solution onto the rotating substrate.

15. The method as claimed in claim 1, wherein the step of displacing the surfactant-containing liquid with a developing solution is carried out using a nozzle capable of depositing the developing solution in a substantially band shape, the nozzle being scanned over the substrate while depositing the developing solution.

16. The method as claimed in claim 1, wherein the step of displacing the surfactant-containing liquid with a developing solution is carried out by using a plurality of nozzles each capable of depositing the concentration-adjusted developing solution in substantially a band shape, the plurality of nozzles being scanned over the substrate while depositing the developing solution.

17. The method as claimed in claim 1, wherein the step of applying a surfactant-containing liquid onto the resist film is carried out by using a nozzle capable of depositing the surfactant-containing liquid in dropwise fashion, the nozzle being positioned over the center of the substrate while depositing at least one drop of the surfactant-containing liquid onto the substrate while rotating the substrate.

18. The method as claimed in claim 1, the method further comprising:

selecting the concentration of the developing solution in accordance with one or more characteristics of the surfactant-containing liquid and the resist film.

19. The method as claimed in claim 1, wherein the developing includes rotating the substrate having the developing solution supplied thereto for a prescribed time sufficient to permit a developing reaction to proceed.

20. A method for processing of a resist film formed on a substrate, the method comprising the steps of:

depositing a resist film on the substrate;

applying a surfactant-containing liquid onto the resist film, wherein the surfactant-containing liquid is chosen based on one or more characteristics of the resist film;

selecting a concentration of a developing solution in accordance with one or more characteristics of the surfactant-containing liquid and the resist film;

supplying the developing solution onto the resist film after applying the surfactant-containing liquid on the substrate to displace the surfactant-containing liquid to displace the surfactant-containing liquid;

developing the resist film by allowing the substrate having the developing solution supplied thereto to stand for a prescribed time sufficient to permit a developing reaction to proceed; and

thereafter, rinsing the substrate.

21. The method as claimed in claim 20, wherein the surfactant-containing liquid comprises at least one of an ionic surfactant, a nonionic surfactant, an anionic surfactant, and a cationic surfactant.

22. The method as claimed in claim 20, the method further comprising:

determining a concentration for the surfactant-containing liquid based on the resist film thickness.

23. The method as claimed in claim 20, the method further comprising:

determining a concentration for the surfactant-containing liquid based on the resist film and one or more characteristics of selecting the concentration of the developing solution based on the concentration of the surfactant-containing liquid.

24. The method as claimed in claim 20, the method further comprising:

determining a concentration for the surfactant-containing liquid based on the water solubility of the resist film.

25. The method as claimed in claim 20, the method further comprising:

determining a contact angle for the developing solution on the resist film; and

determining a concentration for the surfactant-containing liquid effective to achieve a decrease in the contact angle.

26. The method as claimed in claim 20, the method further comprising:

prior to applying the surfactant-containing liquid, transferring the substrate having the resist film thereon into a developing unit; and

positioning the substrate on a spin chuck,

wherein the applying and supplying are performed while rotating the spin chuck.

27. The method as claimed in claim 26, the method further comprising:

after the rinsing, drying the substrate while rotating the spin chuck; and

transferring the substrate out of the developing unit.

28. The method as claimed in claim 20, further comprising rotating the substrate during the step of applying, and wherein the step of applying a surfactant-containing liquid onto the resist film is carried out by using a nozzle capable of depositing the surfactant-containing liquid in a substantially circular shape, the nozzle being positioned over the center of the substrate while depositing the surfactant-containing liquid onto the rotating substrate.

29. The method as claimed in claim 20, wherein the step of applying a surfactant-containing liquid onto the resist film is carried out by using a nozzle capable of depositing the surfactant-containing liquid in substantially a band shape, the nozzle being scanned over the substrate while depositing the surfactant-containing liquid.

30. The method as claimed in claim 20, wherein the step of applying a surfactant-containing liquid onto the resist film is carried out by using a plurality of nozzles each capable of depositing the surfactant-containing liquid in substantially a band shape, the plurality of nozzles being scanned over the substrate while depositing the surfactant-containing liquid.

31. The method as claimed in claim 20, further comprising rotating the substrate during the step of supplying, and wherein the step of supplying the developing solution onto the resist film is carried out by using a nozzle capable of depositing the developing solution in a substantially circular shape, the nozzle being positioned over the center of the substrate while depositing the surfactant-containing liquid onto a rotating substrate.

32. The method as claimed in claim 20, wherein the step of supplying the developing solution onto the resist film is carried out by using a nozzle capable of depositing the developing solution in a substantially band shape, the nozzle being scanned over the substrate while depositing the developing solution.

33. The method as claimed in claim 20, wherein the step of supplying the developing solution onto the resist film is carried out by using a plurality of nozzles each capable of depositing the developing solution in substantially a band shape, the plurality of nozzles being scanned over the substrate while depositing the developing solution.

34. The method as claimed in claim 20, wherein the step of applying a surfactant-containing liquid onto the resist film is carried out by using a nozzle capable of depositing the surfactant-containing liquid in dropwise fashion, the nozzle being positioned over the center of

the substrate while depositing at least one drop of the surfactant-containing liquid onto the substrate while rotating the substrate.

35. The method as claimed in claim 20, wherein the substrate having the developing solution supplied thereto is rotated for at least a portion of the prescribed time.

Evidence Appendix

None

Related Proceedings Appendix

None